

AN OUTBREAK OF SALMONELLOSIS IN DENMARK CAUSED BY PORK FROM A SINGLE SLAUGHTERHOUSE

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Due to a rise in the endemic level of *Salmonella* Typhimurium infections in humans in Funen county, an outbreak of this serotype was discovered in the first week of September 1996. During the outbreak period (28 August - 14 October 1996) approximately 170 culture confirmed cases were registered at Statens Serum Institut. Almost all isolates were of phage type 12, which is frequently found in pork in Denmark - about 60% of *S. Typhimurium* isolates from pork are of DT 12 (Anon., 1997).

The geographic distribution and preliminary interviews of patients suggested that pork from a small slaughterhouse in Funen county might have been the source of this outbreak. Therefore, it was decided to conduct a case-control study to determine risk factors associated with *S. Typhimurium* infection and in particular to elucidate the role of the implicated slaughterhouse.

METHODS

The study design was a matched case-control study. A case was defined as any person with a positive stool sample for *S. Typhimurium*, where the sample was received at Statens Serum Institut on 16 September 1996 or later. The isolated *S. Typhimurium* strains were at a later stage investigated by phage typing and pulsed field gel electrophoresis. Patients with intermittent diarrhoea, chronic bowel disease, previous salmonella infection, or patients, who had been abroad the week before disease onset, were excluded from the study. From the Civil Registration System in Denmark, two controls, matched for age, sex, and municipality were randomly selected for each case. Controls with diarrhoea or abdominal pain and fever in the last month before the interview were excluded. Also controls with previous salmonella infections or controls, who had been abroad the week before the interview, were excluded and replaced by another control. Cases and controls were interviewed using a questionnaire and asked about their symptoms and food consumption in the 3 days prior to onset of illness (cases) or interview (controls). Details of retail outlets, where pork was purchased and food eaten outside the home, were also obtained. Telephone interviews were conducted between 26 September and 4 October 1996.

From the local Municipal Food and Environmental Laboratories and the Danish Veterinary Service information regarding the suppliers of the retail outlets was collected, and compared with the information given by the cases and controls.

The questionnaire data were entered in Epi-Info 6, version 6.02. The analyses were carried out in SAS® version 6.11. using conditional logistic regression (the PHREG procedure).

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RESULTS

Descriptive epidemiology: In the study period a total of 66 patients in Funen county were found positive for *S. Typhimurium*. Fifty patients were contacted for telephone interview. One patient was excluded because of previous salmonella infection and two because of chronic bowel disease. For 5 cases only one control was interviewed. Out of a 112 controls, 3 were excluded because of previous salmonella infection and 20 (17.8%) because of diarrhoea or abdominal pain with fever in the last month before interview.

No significant sex difference was demonstrated among the 47 patients included in the investigation, 25 (53%) were male and 22 (47%) were female. Children and young people dominated among the cases. The median age was 18 years (25% - 75% quantiles: 9 - 39 years). There were no infants, but 3 cases were under 3 years of age. Most cases of possible person-to-person transmission were observed among children and young people. Practically all of the cases had diarrhoea and abdominal pain, and 26% had bloody diarrhoea.

Microbiology: *S. Typhimurium* DT 12 was detected in 46 of the 47 patients. Of these 45 isolates had identical pulsed-field gel electrophoresis patterns (Kaufmann et al., 1993). This "epitype" was also isolated from a single environmental sample from the slaughterhouse, from one delivery herd and from pork at retail level originating from the same slaughterhouse. However, results from the Danish surveillance of salmonella in pork showed that this type is widely distributed in Denmark (Anon., 1997), and nothing conclusive could be inferred on the basis of the typing results.

Case-control study: The 45 patients infected by the epitype were included as cases. A conditional logistic regression analysis of specific food items could not demonstrate a significant association between a single source or product and acquiring salmonella infection.

However, when looking at the origin of the pork products the patients and controls had eaten 3 days prior to disease onset/interview, a strong and significant relationship became apparent. Of 29 patients, 24 (83%) had consumed pork from retail outlets which had received pork from the slaughterhouse, whereas only 25 (46%) of 54 controls had eaten products with similar origin (conditional logistic regression OR=6.7; CI=1.9-23.5; p=0.0033). For 8 cases and 5 controls, it was impossible to determine the exposure status, and they were excluded from the analysis. Likewise, 6 additional cases exposed to person-to-person transmission were excluded.

DISCUSSION

In order to obtain the same exposure possibility for cases and controls, the controls should in theory have been questioned about their food consumption in the same 3 days as their respective case. But unlike the patients, one cannot expect the control persons to remember in detail, what they have consumed in a specific 3 day period 3-4 weeks prior to the interview. Neglecting this point could have resulted in far more controls compared to cases being classified wrongly with regard to their exposure. This type of differential misclassification is commonly referred to as recall bias (Rothman, 1986). Therefore, it was concluded that the most valid information was obtained by asking the controls about the 3 days immediately before the interview. Misclassification of the exposure factor would then be almost the same for cases and controls. This nondifferential misclassification will always tend to underestimate the effect of the exposure, which in investigations like the present is preferred to an overestimation (Kleinbaum et al., 1982).

Not all patients reported having eaten pork which could be traced to the slaughterhouse. Possible explanations for this observation include consumption of contaminated pork outside the

3-day period. Furthermore, inaccurate recall of food eaten or cross contamination of other food items may have occurred. The supply network was complex, and some contradictory information regarding the suppliers of the retail outlets was given by the authorities. Thus some links to the suspect producer were possibly not identified. Finally, some sporadic cases of infection may have occurred, but because of the "epitype's" wide distribution, these could not be distinguished from cases related to the outbreak.

In outbreaks of food borne diseases, where 1) the pathogen is commonly isolated, 2) the contaminated food is commonly eaten and 3) the cases are spread over a large geographical area, the source of the outbreak can be very difficult to track down (Palmer, 1990). This is confirmed by the fact, that outbreaks which are successfully investigated, tend to be caused either by a relatively rare pathogen and/or a relatively uncommon food. This study describes an outbreak caused by a commonly occurring pathogen in a commonly eaten food item. However, the outbreak was restricted to a geographical distinct area, which resulted in a relatively rapid recognition of the outbreak and aroused the suspicion, that the source must have been a producer primarily supplying the eastern part of Funen with pork. Pork was suspected because *S. Typhimurium* DT 12 in Denmark occurs most frequently in pork. The reason why pork did not turn out to be a risk factor in the analysis, was the very fact that pork is a very commonly eaten food item. The proportions of patients and controls who had consumed pork were almost equal. The difference was, that patients primarily had eaten pork which could be traced to the suspected slaughterhouse, while the same was the case for only one half of the controls.

CONCLUSION

The epidemiological evidence strongly suggests, that pork from a single slaughterhouse was the cause of the outbreak. Even though the case-control study was conducted rather late in the course of the outbreak, where person-to-person transmission and cross contamination of other products could have veiled the primary source, a strong significant association between contracting salmonellosis and consuming pork from the slaughterhouse was observed.

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